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Progress of BARBERRY ERADICATION

THE COMMON BARBERRY (*Berberis vulgaris*) carries and spreads black stem rust of wheat.

The common barberry and all its horticultural varieties, including the purple-leafed variety, should be dug up and burned wherever found. All roots must be carefully removed, so that no sprouts will appear. The spot should be carefully watched and all sprouts appearing and all seedlings found carefully eradicated.

The Japanese barberry (*Berberis thunbergii*), commonly used now for borders, does not rust; it is harmless. If you have this kind, keep it.

Most of the common barberry bushes have been removed from cities and towns in the thirteen States cooperating. A farm-to-farm survey is now being made. An area which approximates 183 counties has been surveyed. Thousands of cultivated barberries on farms and millions of escaped barberries have been located and eradicated within this area. At least 650 counties remain that should be surveyed. No doubt many barberries will be found on the farms in these counties as the survey progresses.

Barberries escaped from cultivation have been located on 1,805 farms in 151 counties. All pastures, fence rows, stream banks, woodlands, orchards, windbreaks, old stone quarries, or rocky cliffs in the vicinity of fruiting barberries must be inspected for escaped barberry bushes.

Definite results have been obtained in the control of black stem rust in local areas by the eradication of the barberry.

No definite practical stem-rust control generally over the entire spring-wheat area should be expected from the eradication of barberries until this entire area and perhaps some surrounding States are freed from all common barberries, whether cultivated or escaped. All sprouts and seedlings also must be destroyed.

Every man, woman, and child should learn to know this bush and see to it that wherever found all bushes are thoroughly removed and burned.

UNITED STATES DEPARTMENT OF AGRICULTURE
DEPARTMENT CIRCULAR 188

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief
Washington, D. C. Issued October, 1921

PROGRESS OF BARBERRY ERADICATION.[1]

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BARBERRIES AND BLACK STEM RUST.

THE CAMPAIGN for the eradication of the common barberry in 13 North-Central States has been in progress during three field seasons, 1918, 1919, and 1920. Very encouraging results have been obtained in eradication, and some striking discoveries have been made concerning the distribution of barberry bushes and of rust.

The purpose of this circular is to report the progress that has been made in eradicating the common barberry. The rust itself is discussed only briefly and incidentally.

LOSSES CAUSED BY THE RUST.

Losses from black stem rust have been large in the average year, but in years of rust epidemics they have been enormous. In the principal winter-wheat States rust losses, while frequent, usually are confined to limited districts. In the spring-wheat belt rust attacks are likely to be more widespread because of the late maturing of spring wheat. The principal epidemics occur in the spring-wheat

[1] The information contained in this circular has been obtained and the manuscript prepared in cooperation with the agricultural colleges, departments of agriculture, and other agencies in the following 13 States: Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Montana, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin, and Wyoming. The writer wishes to thank the leaders and collaborators in barberry eradication for their hearty cooperation in furnishing data.

States of the upper Mississippi Valley and the adjacent Provinces of Canada.

The estimated rust loss on both spring and winter wheat in the whole United States during the 5-year period from 1916 to 1920, inclusive, was 323,436,000 bushels. The estimated production of wheat in the same period was 3,932,361,000 bushels. The estimated production and losses by years are shown in Table I.

TABLE I.—*Estimated losses of wheat from black stem rust in the United States for the 5-year period from 1916 to 1920, inclusive.*

Year.	Wheat production and losses from black stem rust.	
	Production.	Losses.[a]
	Bushels.	*Bushels.*
1916	636,318,000	180,000,000
1917	650,828,000	16,203,000
1918	917,100,000	804,000
1919	940,987,000	71,417,000
1920	787,128,000	55,012,000
Total	3,932,361,000	323,436,000

[a] Data obtained in cooperation with the Plant-Disease Survey of the Bureau of Plant Industry, United States Department of Agriculture.

The average annual loss in this period was 64,686,000 bushels of wheat. Estimates of the losses of other cereals from black stem rust in 1919 only were 4,369,000 bushels of barley, 15,027,000 bushels of oats, and 31,000 bushels of rye.

RELATION OF THE BARBERRY TO RUST.

Each season many local outbreaks of stem rust have been traced directly to barberry bushes. The rust spreads from the infected bushes to surrounding grain and grasses, progressing most rapidly in the direction of the prevailing wind. Hedges and so-called "wild" bushes in the country and hedges and large single bushes in the suburbs of cities and in small towns are the worst infection centers. Bushes well inside large cities also may spread the rust either by means of the wind or by progressing on grasses to more distant grain fields. Rust spores are known to have been carried 6 miles by the wind. The spread of rust from barberries can best be illustrated by a few concrete examples.

On July 3, 1920, a hedge of barberries was found on the northeast quarter of section 27, Sisseton Township, Roberts County, S. Dak. This hedge contained about 50 bushes more than 15 years old and some 25 seedlings scattered through the grove near the old bushes. Examination of the fields on this date showed very severe infection on all the wheat and wild barley within 200 feet of the barberries.

The greatest amount of infection was in a wheat field west of the barberries. Oats, about 200 feet north, also were rusted severely. The amount of rust diminished noticeably as the distance from the hedge increased. At this time the rust had not spread to distances greater than 1 mile from the hedge, but two weeks later some rust could be found in practically all grain fields in the county. Although widely distributed and easily found at this later date, it was

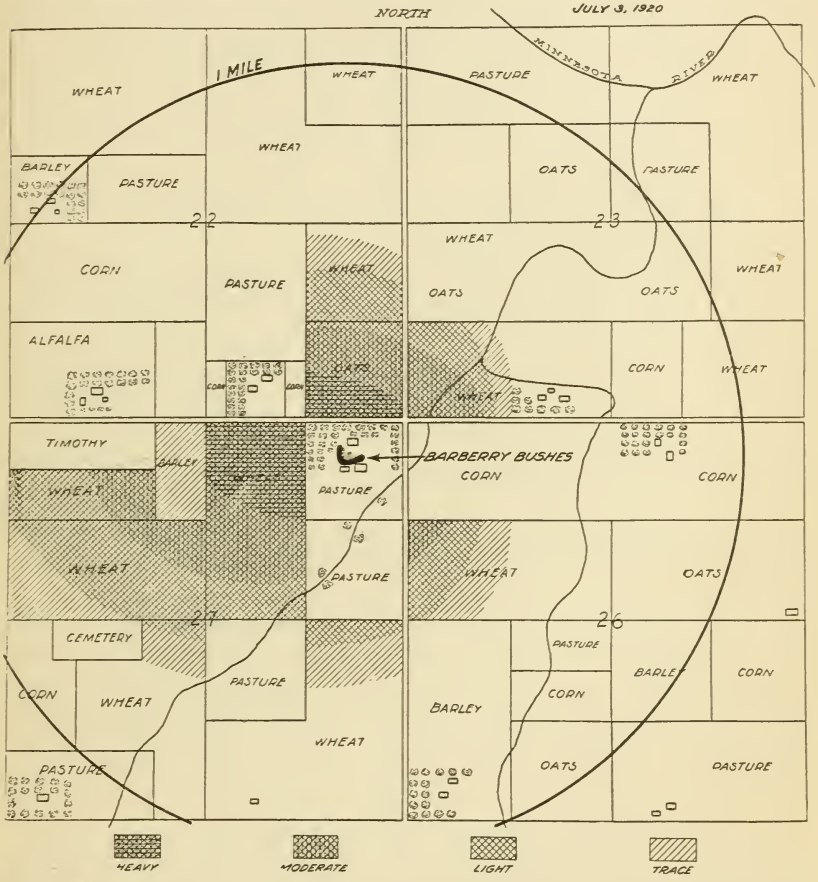

FIG. 1.—Map showing the spread of black stem rust from a hedge of common barberry on section 27, Sisseton Township, Roberts County, S. Dak., in 1919. The density of the shading is in proportion to the severity of rust infection on grains and grasses in the surrounding fields.

not abundant in any of the fields except in those close to these barberries. Wild grasses, which often play an important part in the distribution of rust, were of little importance in this case. Farmers who have lived in this district say that for the past 15 years or more the black stem rust always has been noticed first in the vicinity of this farm, and that wheat grown in the field west of the barberries always was severely rusted at harvest. Figure 1 is a map showing

the location of this barberry hedge and the infection of the adjacent fields of grain.

On a farm in Stephenson County, Ill., in July, 1920, a few large barberry bushes were found in the corner of a wheat field. A number also were found about the house just across the road. Along a stream in a woodland pasture north and east of this field of wheat were found a number of barberries, evidently resulting from seeds scattered by birds feeding on the older barberry bushes near the corner of the field. The wheat in this small field was from 95 to 100 per cent rusted. Oats in near-by fields were from 60 to 75 per cent rusted. On August 4, in this same county, many barberry bushes were found scattered over a tract of 8 or 9 acres of wooded pasture. Not far away was a field of very severely rusted spring wheat, while more distant fields of wheat were rusted less severely, in proportion to their distance from the bushes.

In Lake County, Ind., a number of escaped barberries were found in a pasture. All fields of oats within 1 mile in the direction of the prevailing wind were severely infected. Oats 2½ miles distant in the same direction were attacked in diminishing proportion, while fields 3 miles away were rusted slightly or not at all. Wheat 1½ miles away in the same direction was badly rusted, and that 3 miles away was half as severely rusted as that near by. Against the prevailing wind oats half a mile away were rusted about half as badly as on the other side of the barberry bushes. A mile away they were slightly attacked or not at all. Wheat distant 1 mile in this direction was only slightly attacked.

Near Hastings, Nebr., a barberry hedge was located near a farmhouse. The wheat near the barberries was very badly rusted, while that more distant was rusted less heavily and that in fields half a mile away was very slightly rusted. Near-by grasses that are susceptible to rust were severely attacked, but those more distant showed no rust. Many similar cases have been noted in various other States.

REDUCING RUST BY BARBERRY ERADICATION.

Definite and striking results are available to show the local effects of barberry eradication. A few examples will serve as illustrations.

A hedge of purple barberries was located in a rural cemetery near Centerville, Ind., and near-by wheat fields were badly rusted each year. In 1918, when this hedge was discovered, wheat in one field directly north of it was rusted from 75 to 100 per cent, and more distant fields showed from 50 per cent to a trace of infection. This hedge was removed, with the result that no rust has developed since on the grain in this vicinity.

In La Grange County, Ind., numerous infected escaped barberries were located in a woodland. Near-by fields of wheat were severely

rusted, varying from a total loss in the nearest field to 75 per cent in those farther away and 20 per cent in others still more distant. In 1920, after the barberries were removed, observations over the same area showed only a slight amount of rust. That was traceable to a number of rusted sprouts that had appeared.

Near Boston, Ind., in 1917 one large infected barberry bush was located on a certain farm. Oats near by were 20 per cent rusted. Wheat in a field north of the bush showed 100 per cent of infection. Wheat 40 rods northeast of the bush was just as severely affected. Wheat 80 rods northeast was 80 per cent rusted. The bush was removed and observations were made again in 1920. The same fields were sown to the same crops except that the field 80 rods northeast was sown to rye instead of wheat. No rust was to be found on any of the grain.

In 1918 a similar case was noted near Bellbrook, Ohio, where a barberry hedge grew between two wheat fields. Both fields were too badly rusted to harvest. The hedge was removed and the fields again grew wheat in 1919. The resulting crop showed no rust.

In 1919 a badly rusted field of wheat was observed on a farm near Fromberg, Carbon County, Mont. Tracing from the less to the more severely rusted portion of the field, about 25 infected barberries were located about a farmhouse near one corner of the field. The barberries were removed, with the result that no rust has developed since on any of the grain in this vicinity.

Similar results have been obtained in various States in the winter-wheat region. The rust also was reduced on farms in the spring-wheat region where bushes were removed. One such case occurred near Chaffee, N. Dak. Barberries were found planted near a farmhouse, and near-by fields of wheat were rusted to the extent of 100 per cent. Others, farther away, were less rusted. The barberries were removed, and wheat in the fields near by has not been severely infected since.

LIFE STORY OF THE BLACK STEM RUST.

Black stem rust is familiar to most grain growers. Its characteristics and the ways of telling it from other rusts of grains have been described in detail in previous publications.[2] Farmers' Bulletin 1058 of the United States Department of Agriculture, entitled "Destroy the Common Barberry," by E. C. Stakman, gives a short statement of the relation of the common barberry to the black stem rust of grain.

[2] For fuller information regarding the life story of this rust and the relation between the barberry and black stem rust, see "The Black Stem Rust and the Barberry," by E. C. Stakman, in Yearbook of the U. S. Dept. of Agriculture for 1918, pp. 75–100, 8 pl. 1 fig. 1919. (Issued also as Yearbook Separate 796.)

Circulars and bulletins giving information in regard to black stem rust and the common barberry have been issued by most of the 13 States included in the barberry-eradication area. These may be procured by applying to the agricultural colleges or experiment stations of those States.

Briefly stated, the life story of black stem rust is as follows: It starts on the common barberry in the spring from the black or winter spores which live over on stubble or grass. It attacks the leaves, young shoots, and even the fruits. This is the spring or cluster-cup stage, producing yellow spores. This stage of rust spreads from the barberry to grains and grasses, but can not spread from one barberry bush to another. The red rust or summer stage then develops on the stems and leaves of these grains and grasses and continues to develop and spread as long as conditions are favorable. Later in the season, when the wheat heads begin to fill, the black or winter spores are formed in great numbers.

The red spores, which can start rust on grain, rarely survive northern winters, but the black spores live over winter in abundance. In the spring they germinate and produce smaller spores, which attack the barberry, and the process is repeated. It is evident, therefore, that in the North the barberry gives the rust a chance to start in the spring and that the black spores are harmless unless there are barberry bushes near by.

COMMON AND JAPANESE BARBERRIES.

There are many species and varieties of barberry. As a general rule those which resemble the common barberry (*Berberis vulgaris*) carry black stem rust and those which resemble the Japanese barberry (*Berberis thunbergii*) do not. The two species can be distinguished from each other very easily. The common barberry is a tall, erect shrub, often as high as 12 feet, with grayish bark. The branches bear spines, usually in groups of three or more, although sometimes only one or two occur. The leaves are green and have saw-tooth edges. The yellow flowers and red berries are in long, drooping clusters like those of currants. The flowers are small and inconspicuous, but the red berries are numerous and easily seen, usually remaining on the plants throughout the winter. The common barberry spreads rust. Destroy it.

The purple barberry (*Berberis vulgaris* var. *purpurea*) is a widely planted variety of the common barberry. It resembles the common variety in all characters except that its leaves usually are purple in color. It spreads rust. Destroy it.

The Japanese barberry is a low, gracefully spreading shrub with reddish bark, usually 2 or 3 and seldom more than 4 or 5 feet tall. The spines are smaller than those of the common barberry and

usually are single, but sometimes in twos and threes. The edges of the leaves have no teeth. The flowers are yellow and the berries are red, like those of the common form, but both the flowers and the berries are in very small bunches of two or three, like gooseberries. This bush does not spread rust.

RELATION OF MAHONIAS TO RUST.

It has been found recently that two distinct species of Mahonia have been confused in the far Northwestern States. One is *Berberis* (*Mahonia*) *aquifolium*, a tall, erect species with pointed leaves which have shining upper surfaces. Its geographic range extends from the Pacific coast eastward into the mountain ranges of Idaho. The other is *Berberis* (*Mahonia*) *repens*, a low, spreading species with blunt leaves that are dull on their upper surfaces. The range of this species overlaps that of the other in the mountains of Idaho, and it extends eastward, commonly throughout the Rocky Mountains of Montana, Wyoming, and Colorado. The popular name, Oregon grape, is properly applied to a third species, *Berberis nervosa*, but is loosely used to include all the species of this group.

No infection by black stem rust has been observed so far on either of these species under field conditions where they are growing wild. Rust has been produced on the tall species (*Berberis aquifolium*) in the greenhouse. It is sometimes planted as an ornamental in the Eastern and Central States, and under such conditions it may prove to be susceptible. Its planting, therefore, is not to be encouraged.

THE ERADICATION CAMPAIGN.

ORIGIN.

The common barberry has long been known to spread the black stem rust. It has been repeatedly observed, both by farmers and scientists, that rust is more prevalent in the vicinity of infected barberries than elsewhere, but the eradication of this shrub had been attempted only in very local areas in the United States. The experience of Denmark has proved conclusively the relation of barberry bushes to black stem rust. For more than 100 years that country was troubled with black stem rust. In 1903 the Danish Legislature finally passed a law for the complete eradication of the bush. As a result the barberry was destroyed everywhere throughout the kingdom. Since that time Denmark has not experienced a single rust epidemic, and within the last year reliable authorities have testified that no stem rust has been observed except where an occasional infected barberry seedling was found. Similar testimony has been given from parts of Sweden where barberries have been eradicated.

In 1917 the Legislature of North Dakota passed a law providing for the eradication of all rust-bearing varieties of barberry within

the State. The Legislature of South Dakota in 1918 enacted a law placing the rust-bearing varieties of barberries in the class of noxious weeds.

The present campaign for barberry eradication was begun in April, 1918. It was the result of agitation by scientists during the preceding years, particularly in 1916 and 1917, following the severe rust epidemic of 1916. During the autumn of 1917 a movement to encourage the eradication of the common barberry was begun in Minnesota, and plans were made for a similar movement in Iowa. A conference of plant pathologists and other interested persons from North Dakota, South Dakota, Minnesota, and Wisconsin was held in Washington, D. C., in November, 1917, to consider barberry eradication as a means of reducing rust losses.

In February, 1918, a meeting of plant pathologists and other interested persons from North Dakota, Minnesota, Indiana, Iowa, and Wisconsin was held at Chicago. It was the opinion of the pathologists present and of other pathologists whose sentiments were obtained by letter that everything possible should be done to bring about the destruction of the common barberry in the upper Mississippi Valley. As a result of this conference a delegation from the States represented proceeded to Washington, D. C., to confer with the officers of the United States Department of Agriculture. There it was decided to begin immediately a preliminary campaign of education and survey under the emergency appropriation for stimulating agriculture, and field work was begun about April 1. An appropriation of $150,000 was asked for barberry eradication in the fiscal year beginning July 1, 1918. As the appropriation bill was delayed in passage, the work was continued from July 1 to September 30, 1918, on emergency funds. The regular appropriation bill finally was approved October 1, 1918. Since that time eradication has been continued in each of the 13 States. Investigation of barberry distribution and of rust injury has been conducted in some of the neighboring States also.

A Federal quarantine was placed, effective May 1, 1919, prohibiting the movement into the eradication area of any barberries known to harbor the black stem rust of wheat and other grains.

ORGANIZATION.

The campaign was organized in February and March, 1918, by the Office of Cereal Investigations of the Bureau of Plant Industry, United States Department of Agriculture, in cooperation with the following 13 States: Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Montana, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin, and Wyoming.

In most of the States the State college or experiment station designated an official to represent the State in planning and conducting the campaign. In each State a leader and field assistants were employed by the Office of Cereal Investigations. Where barberry-eradication laws existed or as new laws became effective, informal cooperation was established with the law-enforcing agency of each State. To this agency is furnished information of the location of bushes which property owners have refused or neglected to remove, so that complete eradication can be effected by legal means. In April, 1920, formal cooperation was effected with the extension division of the agricultural college of each of the 13 States.

As a rule, the State leader is employed throughout the year in each of the 13 States. Field assistants in considerable numbers are employed during the summer months of each year. During the summer of 1920 about 65 field men were employed during an average period of three months. In addition, stenographers are furnished and some temporary field helpers employed. Help is given also by collaborators from the departments of plant pathology, botany, and agronomy and from the experiment station, education, and extension divisions of the State colleges of agriculture. State entomologists, horticultural inspectors, and members of horticultural boards and of State departments of agriculture, who are charged with the enforcement of State laws, give considerable aid in actual inspection and in eradication by law enforcement.

METHODS.

PUBLICITY.

The combating of a plant disease by the destruction of the plant that carries it during part of the year and spreads it to growing crops was a departure from the usual method of plant-pest control. Naturally, city property owners having barberries had to be shown conclusively the necessity of destroying them. Even the farmer, whose crops are protected by the destruction of this bush, had to be shown that they contribute to his loss or that of his neighbors before he would expend time and labor in removing bushes found on his property. This was especially true when he had to expend much money and many hours of tedious labor in cleaning out escaped bushes that had grown up in his woodland or pasture from seeds scattered by birds.

In view of these facts an extensive publicity campaign was arranged in connection with the early survey. This publicity was of three types, namely, printed matter, talks, and demonstrations. The printed matter was of various sorts, adapted to reach all kinds of communities and all kinds of people in a community.

Large colored posters were placed in banks, mills, creameries, elevators, and other places of public gathering. Bulletins and circulars, circular letters, lithographed cards, and cartoons were distributed over the whole territory to periodicals, organizations, and individuals. General news articles regarding the campaign were supplied to State and county papers, and shorter articles of local interest were furnished to local papers. More comprehensive articles were contributed to farm journals and magazines.

Talks were made by Federal, State, and county men and other interested persons to residents in both urban and rural communities. Adults were addressed in farm organizations, theaters, women's clubs, park boards, commercial clubs, civic or commercial conventions, and at other public meetings. Young people were instructed in rural and city schools, both graded and high schools, in boys' and girls' clubs, and through boy-scout and girl-scout organizations.

Demonstrations were put in suitable store windows of the cities and towns, and demonstration booths were placed at county and State fairs and even in parks and along roadways. Films and lantern slides were used in motion-picture theaters, schools, and other public meetings. Fourteen copies of a film containing a humorous animated cartoon are kept in circulation in the different States. In addition, the object and the need of barberry eradication were discussed with thousands of individuals.

SURVEY.

Field men employed by the Office of Cereal Investigations under the direction of a leader in each State inspect all city and rural properties in order to locate common barberries. Records are made of all properties on which barberry bushes have been observed, with the name of the owner or occupant, the legal description of the land, number and location of bushes found and of those removed, with other necessary data. Bushes not immediately removed are tagged, and the State official charged with enforcing eradication is notified. He, in turn, notifies the property owner in person if he can be found; otherwise, notice is sent by mail. Return cards usually are left to be signed and mailed to show when the bushes have been eradicated.

The survey was made first in cities, towns, and villages. This was done because most of the bushes were supposed to be in such places and because it was possible to work up favorable public sentiment quicker where daily papers and larger and more frequent public gatherings occurred. The inspection of city properties usually was done on foot. Travel between towns was by railroad or trolley line, but automobiles and horse-drawn vehicles were used in some cases. The survey of cities and towns occupied all of 1918 and much of 1919.

Preliminary inspection showed that probably there are more barberries in the country than in the cities and that many of these are escaped from cultivation. As rapidly as the survey of the cities and towns was completed in the various States, a rural survey was begun. In this, all farmsteads, woodlands, windbreaks, timber claims, brushy pastures, stone quarries, stream banks, and fence rows were inspected carefully for escaped barberries, especially whenever cultivated fruiting bushes were found near by. This farm-to-farm survey is being completed, county by county, in certain definite areas in each State as rapidly as funds permit. In the more western States of the group the long-settled areas likely to contain the shrub are carefully inspected, while forests, unsettled dry-land areas, and more recently and thinly settled sections not likely to have shrubbery are not surveyed. Travel is usually by an automobile carrying two men. One drives the car and the other maps the location and makes notes of bushes. Both inspect properties.

RESURVEY.

Careful resurveys are as necessary and important as the original inspections of properties. Though most bushes are located in the first survey, a few may be missed. Bushes located and reported by field men sometimes are missed by property owners or laborers engaged in removing them. Some property owners fail to remove their bushes, or properties change owners before the bushes are removed. When bushes are not carefully removed but are merely cut off level with the ground or when fragments of roots are left in the soil, a growth of sprouts is almost certain to follow. The ground beneath old bushes often is covered with scattered berries, or in digging the bushes some of the berries fall to the ground. These germinate and grow readily in the soil loosened by the digging. Others may be scattered by birds. By these and other agencies the seeds find their way into neglected fence rows, thickets, and woodlands, and a new crop of barberries is started. The small seedlings under leaves or among the grass and weeds can not always be seen. All such sprouts and seedlings are even more likely to become rusted than are mature bushes and are as great a menace to grain crops. To neglect the destruction of these would serve only to nullify such work as has already been done.

At least two reinspections are necessary, and to guarantee a thorough clean-up others should be made. The property owner can aid in this. He should watch the spot where barberries grew and kill the sprouts and seedlings.

ERADICATION PROCESSES.

If the number of bushes is not too great to justify spending the necessary time, the field men may aid in removing the bushes at once.

Larger plantings, as a rule, must be removed by the owner himself, though Federal or State men generally supervise the operation.

Property owners who refuse to remove bushes or to allow them to be removed or who neglect to remove them after being notified of their presence are reported to the State officials who have authority to enforce the State laws compelling barberry eradication. Property owners, both in cities and towns and on the farm, usually have shown great interest and have cooperated heartily in the work. If the bushes are small they can be removed easily with a spade or grub hoe. Large bushes are pulled out by teams hitched to log chains securely fastened around the bush at the base. Hoisting tackle makes the job easier. Tractors, trucks, or even automobiles sometimes are substituted for teams. Very large bushes, especially those in stony places on exceedingly hard ground or on rocky cliffs, are quickly removed by the use of dynamite. Its use is not advisable if the bushes are near buildings. The application of approximately 1 quart of fuel oil, dip oil,[3] or a mixture of one part of dip oil to five parts of fuel oil to the base of the plant, after the top has been cut off, has been tried with some success; but this is recommended only where digging is impracticable and frequent reinspections are possible. In digging or removal by other means, care must be taken that all large and small roots, from which sprouts may grow, are found and removed. These roots can be distinguished easily by their bright yellow color. The larger ones can be removed with a grub hoe or spade, but the smaller ones can be more readily pulled by hand. After the bushes are removed, all dirt should be shaken from the roots and care taken not to place them where they may grow again. It is preferable that all parts of the bushes be burned immediately. Care should be taken also not to scatter the mature berries, as hundreds of seedlings may grow where one bush was before. Watch the spot and the vicinity for both seedlings and sprouts and destroy them.

SUMMARIZED RESULTS.

The campaign for barberry eradication has advanced through its third field season. The results will be summarized first by years and then by States.

SUMMARY BY YEARS.

RESULTS IN 1918.

During the first season an organization was formed, a campaign of publicity and education conducted that reached out to all parts of the territory included, and surveys to locate bushes were made in the

[3] Acknowledgments are due W. S. Regan and S. B. Detwiler for the results of investigations in the use of these oils. Dip oil is a 25 per cent cresol. Fuel oil of light grade, 36.3° Baumé test, was used.

cities and towns of most of the 13 States previously mentioned. The greatest efforts were exerted where apparently they could accomplish the largest results in the quickest time. Several hundred thousand barberry bushes were removed through the campaign of education, especially from nurseries and institutions.

Twelve States either found that existing laws covered the situation, passed amendments to them, or made plans for the enactment of appropriate legislation.

Many barberry bushes were found in cultivation on farms in the vicinity of towns, and numerous reports of both cultivated and escaped bushes were received. For this reason, preliminary farm-to-farm surveys were planned in representative counties in a number of the States.

Table II gives the results of the survey from April 1 to December 31, 1918.

TABLE II.—*Data showing the results obtained in the barberry-eradication campaign from April 1 to December 31, 1918.*

State.	Number of properties having bushes.					Number of bushes.				
	In cities and towns.	In country.		Total properties.	Cleared of bushes.	In cities and towns.	In country.		In both cities and country.	
		Escaped bushes.	Total.				Escaped.	Total.	Found.	Removed.
Colorado	240	0	0	240	100	1,808	0	0	1,808	890
Illinois	3,496	0	0	3,496	1,851	41,419	0	0	41,419	25,343
Indiana	2,558	16	91	2,649	2,015	66,869	2,215	6,540	73,409	56,435
Iowa	5,241	0	221	5,462	4,229	610,866	0	21,796	632,662	604,022
Michigan	515	9	173	688	323	12,543	205	2,355	14,898	8,573
Minnesota	1,736	2	298	2,034	1,968	572,849	7,684	96,023	668,872	664,586
Montana	0	0	0	0	0	0	0	0	0	0
Nebraska	2,757	0	15	2,772	1,053	69,211	0	2,701	71,912	31,918
North Dakota	248	0	1	249	249	1,926	0	24	1,950	1,950
Ohio	0	0	0	0	0	0	0	0	0	0
South Dakota	175	5	20	195	22	18,425	1,191	2,145	20,570	1,184
Wisconsin	5,061	95	346	5,407	4,954	267,034	66,143	44,756	311,790	295,574
Wyoming	17	0	1	18	0	2,948	0	1	2,949	0
Total	22,044	127	1,166	23,210	16,764	1,665,898	77,438	176,341	1,842,239	1,690,475

RESULTS IN 1919.

During the second season the eradication campaign developed two phases, the original survey and a resurvey. In the original survey the inspection of city and town properties was continued and practically completed. Systematic farm-to-farm surveys were begun, as previously planned. Minnesota completed 3 counties and surveyed parts of 5 others. North Dakota completed 4 counties, Indiana 12 counties, and Nebraska, working by townships, covered the equivalent of 7 counties. As the city and town survey was not completed in Illinois, Iowa, Michigan, and South Dakota, the farm-to-farm survey was confined to a few townships in each of these States. In Ohio and

Wyoming the campaign was not begun until the spring of 1919, so the survey of cities and towns kept all available men busy during that year. In Colorado, after completing the survey of a few cities and towns not covered in 1918, a rather careful inspection was made of definite irrigated and dry-farmed areas and some river valleys supposed to contain cultivated barberries. In Montana the survey of all cities and towns was completed, and all the important cultivated rural areas, including the farms of the principal irrigated districts, the farms in all the main river valleys, and all large ranches in other parts of the State, were inspected.

The resurvey was carried on simultaneously with the original survey. Its purpose was to determine what bushes, previously reported, had not been removed and whether sprouts and seedlings had appeared where bushes had been dug. During the resurvey the men revisited 2,967 city properties and 531 farms from which 121,710 bushes which had been previously reported had not been removed. During the resurvey 110,257 bushes were removed from 3,364 properties. A total of 11,048 sprouts also were found and removed. These results proved that the resurvey was a necessary part of the campaign and that unless a careful reinspection was made many bushes would remain and a new crop would develop from sprouts and seeds.

Table III shows the results obtained in 1919.

TABLE III.—*Data showing the results obtained in the barberry-eradication campaign from January 1 to December 31, 1919.*

State.	Number of properties having bushes.					Number of bushes.					Sprouts found and removed in the resurvey.
	In cities and towns.	In country.		Total properties.	Cleared of bushes.	In cities and towns.	In country.		In both cities and country.		
		Escaped bushes.	Total.				Escaped.	Total.	Found.	Removed.	
Colorado	1,206	9	41	1,247	1,139	16,169	50	1,689	17,858	16,019	.....
Illinois	2,931	27	126	3,057	3,879	38,113	996	7,177	45,290	55,861	.....
Indiana	452	1	186	638	663	7,429	8	2,763	10,192	17,435	736
Iowa	1,398	150	454	1,852	2,513	31,150	27,054	47,014	78,164	104,643	2,883
Michigan	2,726	828	2,986	5,712	3,850	20,433	50,415	83,897	104,330	60,971	.....
Minnesota	890	128	326	1,216	1,185	13,918	36,685	41,523	55,441	50,541	.....
Montana	151	1	37	188	169	6,575	1	2,031	8,606	8,524	1,073
Nebraska	122	.....	42	164	821	878	.....	1,693	2,571	14,309	.....
North Dakota	96	.....	29	125	125	896	.....	241	1,137	1,137	78
Ohio	3,356	25	153	3,509	1,446	189,669	2,666	5,395	195,064	107,159	.....
South Dakota	190	11	43	233	309	3,473	1,680	3,354	6,827	18,701	.....
Wisconsin	541	118	183	724	739	7,682	1,561,251	1,562,003	1,569,685	1,569,763	6,166
Wyoming	45	.....	5	50	10	861	.....	37	898	326	112
Total	14,104	1,298	4,611	18,715	16,848	337,246	1,680,806	1,758,817	2,096,063	2,025,389	11,048

During the 2-year period from April 1, 1918, to December 31, 1919, approximately 1,935,000 bushes were found on 5,777 farms. Of these, 177,000 were cultivated on 4,352 farms. The remaining

1,758,000 were escaped from cultivation on 1,425 farms. These results showed conclusively that careful inspection was required on practically all farms in Iowa, Illinois, Indiana, and Ohio and on all farms in the settled portions of Minnesota, Wisconsin, and Michigan. In addition, it was decided that a farm-to-farm survey was necessary east of the Missouri River in North Dakota and South Dakota, in eastern Nebraska as well as in many counties in southern and western Nebraska, and in the older settled districts in Wyoming and the unsurveyed portion of Colorado. The prevalence of rust on the barberries and the evident spread of rust from these proved that all barberries would have to be removed from the entire area before the campaign could be expected to yield anything but local results.

RESULTS IN 1920.

During 1920, the third season, efforts were concentrated on the farm-to-farm survey, although a resurvey of cities and villages in the counties covered was carried on at the same time. The farm-to-farm survey covered an area equivalent to approximately 88 counties. In Ohio it covered 7 counties along the western border; in Indiana, 7 counties; in Michigan, 5 counties; in Illinois, 3 counties; in Wisconsin, 4 counties; in Iowa, 16 counties; in Minnesota, 9 counties and the greater portion of another; in Nebraska, the equivalent of 11 counties; in South Dakota, 7 counties; and in North Dakota, 7 counties. In Colorado the survey was completed in a number of mountain valleys which were portions of 28 different counties.

TABLE IV.—*Data showing the results obtained in the barberry-eradication campaign from January 1 to December 31, 1920.*

State.	Number of properties having bushes.					Number of bushes.					Sprouts found and removed in the resurvey.
	In cities and towns.	In country.		Total properties.	Cleared of bushes.	In cities and towns.	In country.		In both cities and country.		
		Escaped bushes.	Total.				Escaped.	Total.	Found.	Removed.	
Colorado	22	1	4	26	269	588	1,347	1,388	1,976	4,336	2,596
Illinois	33	166	190	223	568	133	1,205	1,909	2,042	2,663	661
Indiana	71	2	76	147	731	727	218	831	1,558	10,048	1,116
Iowa	27	22	144	171	181	474	2,219	13,313	13,787	10,943	0
Michigan	345	6	210	555	739	2,975	8,123	17,444	20,419	22,732	45
Minnesota	96	52	166	262	314	1,337	6,499	7,885	9,222	17,938	10,162
Montana	1	0	6	7	25	2	0	74	76	147	3,442
Nebraska	56	5	46	102	721	911	801	1,663	2,574	21,966	1,325
North Dakota	79	0	60	139	139	960	0	845	1,805	1,805	137
Ohio	330	16	173	503	1,176	4,091	12,543	14,707	18,798	66,733	0
South Dakota	7	17	81	88	126	26	6,368	8,763	8,789	10,220	913
Wisconsin	178	96	518	696	632	756	1,396,958	1,423,952	1,424,708	348,618	2,118
Wyoming	8	1	1	9	14	123	1	130	253	166	78
Total	1,253	384	1,675	2,928	5,635	13,103	1,436,282	1,492,904	1,506,007	518,315	22,593

All properties in cities, towns, and country on which barberries had been located previously were also covered on a resurvey. In Montana the survey was completed by the inspection of a few cities and villages and a few ranches and farms in the western portion of the State that had not been surveyed. A resurvey was made of all properties upon which barberries had been located previously. In Wyoming city and town surveys were conducted, but no farm-to-farm survey was attempted.

Table IV gives the results of the survey from January 1 to December 31, 1920.

RESULTS IN THREE YEARS.

During the 3-year period from April 1, 1918, to December 31, 1920, almost all cities, towns, and villages in the 13 States of the eradication area were surveyed. In the farm-to-farm survey an area which approximates 183 counties was covered in the original survey, but the necessary resurvey was made in only a few of these counties. This area included all the rural territory necessary to survey in Montana and in the mountainous parts of Colorado. A total of 5,444,309 bushes was located on 44,853 properties. Of these, 4,234,179 bushes were removed from 39,247 properties. Of the 1,210,130 bushes not yet removed from 5,606 properties, about 1,000,000 are seedling bushes under 18 inches in height on one farm in Grant County, Wis.

TABLE V.—*Data showing the results obtained in the barberry-eradication campaign from April 1, 1918, to December 31, 1920.*

State.	Number of properties having bushes.					Number of bushes.					Sprouts found and removed in the resurvey.
	In cities and towns.	In country.		Total properties.	Cleared of bushes.	In cities and towns.	In country.		In both cities and country.		
		Escaped bushes.	Total.				Escaped.	Total.	Found.	Removed.	
Colorado	1,468	10	45	1,513	1,508	18,565	1,397	3,077	21,642	21,245	2,596
Illinois	6,460	193	316	6,776	6,298	79,665	2,201	9,086	88,751	83,867	661
Indiana	3,081	19	353	3,434	3,409	75,025	2,441	10,134	85,159	83,918	1,852
Iowa	6,666	172	819	7,485	6,923	642,490	29,273	82,123	724,613	719,608	2,883
Michigan	3,586	843	3,369	6,955	4,912	35,951	58,743	103,696	139,647	92,276	45
Minnesota	2,722	182	790	3,512	3,467	588,104	50,868	145,431	733,535	733,065	10,162
Montana	152	1	43	195	194	6,577	1	2,105	8,682	8,671	4,515
Nebraska	2,935	5	103	3,038	2,595	71,000	801	6,057	77,057	68,193	1,325
North Dakota	423	0	90	513	513	3,782	0	1,110	4,892	4,892	215
Ohio	3,686	41	326	4,012	2,622	193,760	15,209	20,102	213,862	173,892	0
South Dakota	372	33	144	516	457	21,924	9,239	14,262	36,186	30,105	913
Wisconsin	5,780	309	1,047	6,827	6,325	275,472	3,024,352	3,030,711	3,306,183	2,213,955	8,284
Wyoming	70	1	7	77	24	3,932	1	168	4,100	492	190
Total	37,401	1,809	7,452	44,853	39,247	2,016,247	3,194,526	3,428,062	5,444,309	4,234,179	33,641

These results include more than a million bushes estimated to have been removed from commercial nurseries during the early part of

the campaign. The larger estimated numbers are about 600,000 from Minnesota, 500,000 from Iowa, 200,000 from Wisconsin, and 75,000 from Ohio. Many thousands of bushes were removed from other commercial nurseries, from parks, from institutional grounds, and from private properties of which no records were furnished to the States by the property owners. The outstanding facts are that of 5,444,309 bushes found, only 2,016,247 were in cities, whereas 3,428,062 were on farms. Of these, 233,536 were in ornamental plantings and hedges on 5,645 farms, but 3,194,526 had escaped from cultivation on 1,809 farms. Table V gives the results during the progress of the campaign in the 3-year period from April 1, 1918, to December 31, 1920. The status of the campaign is shown graphically in figure 2.

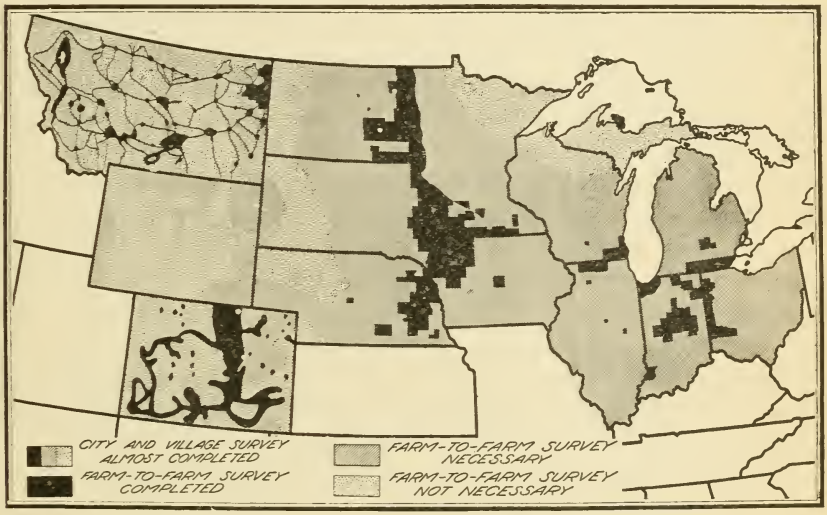
CITY AND VILLAGE SURVEY ALMOST COMPLETED
FARM-TO-FARM SURVEY COMPLETED
FARM-TO-FARM SURVEY NECESSARY
FARM-TO-FARM SURVEY NOT NECESSARY

FIG. 2.—Outline map of the 13 States in the barberry-eradication area, summarizing the progress of the work in 1918, 1919, and 1920 and showing by varied shading the status of the campaign on December 31, 1920.

ESCAPED BARBERRIES.

Common barberries have escaped from cultivation in large numbers within several of the 13 States in the barberry-eradication area. Over 3,000,000 escaped bushes have been found, on approximately 1,800 properties. Numerous other areas, estimated to contain another million bushes, have been reported in counties which the farm-to-farm survey has not yet reached.

The seeds of the barberry are carried by birds that use them as food. The cedar waxwing, crow, robin, and catbird are known to feed upon the fruits. It is very probable that any bird belonging to the groups known as woodpeckers, jays, thrushes, thrashers, robins, fly catchers, and vireos will feed upon the fruits. These birds travel only in the daytime and cover short distances, so their activities as

seed distributers usually are confined to a radius of a few miles from the fruiting bushes. Cattle or other animals that browse upon the foliage and berries also have been known to spread the seeds.

By these means the common barberry has been widely spread and has become well established in many communities. It is found along the banks of streams, in brushy or sparsely wooded pastures, along roadsides, in timber plantings, windbreaks, orchards, groves, and open or brushy woodlands in almost every community where mature fruiting bushes are located.

The rate at which such escaped or so-called wild bushes are increasing in number is fairly rapid, and they are an ever-increasing menace to wheat production. In nearly every case where escaped bushes have been located in large numbers, black stem rust losses have been so severe that the growing of wheat has been abandoned in near-by fields.

If for no other reason than to check the spread of the barberry and prevent its becoming a common pest in pastures and woodlots, barberry eradication is worth while. When one considers the local losses from rust originating from these bushes, the removal of all barberries becomes highly important. One should not forget, also, that each bush will bear more seeds to grow more bushes to scatter more rust, that all these escaped bushes and all the cultivated bushes over the country are each spring spreading millions of spores over the surrounding wheat fields, and that the amount of this spore distribution will increase each year. When one appreciates the full significance of all these facts about the barberry and its natural distribution, then the tremendous importance of this campaign of eradication to the conservation of food and the continuation of wheat growing will become apparent.

A few examples will show how effectively barberries may take possession of pastures and woodlands. About 30 years ago a farmer in Grant County, Wis., planted a hedge of barberries near his house and adjoining a wooded pasture of 300 acres. The cattle browsed on the bushes, eating many of the fruits and thereby distributing the seeds over the pasture in their droppings. In August, 1920, the number of large bushes, 10 or more years old, was estimated at 35,000. Over a million smaller ones, including seedlings, were scattered over the area, both under trees and in the grass. Nine men worked for ten days, eradicating all the plants old enough to bear fruits and also many of the smaller ones. Even after all the small bushes and seedlings are removed, this area will need to be reinspected several times for seedlings and sprouts that may develop.

Near Norfolk, Nebr., a small nursery of purple and green barberries was maintained in a cemetery. From this, seeds had been

scattered by water and birds along fence rows and to a near-by field. Five hundred or more escaped seedlings were found and removed.

In Allen County, Ind., several thousand escaped bushes were found scattered in pastures, woods, and swamps and along fences. These were spread from a single bush brought from Massachusetts nearly 60 years ago.

Escaped barberries were found scattered over six sections of land in Guilford Township, Winnebago County, Ill. All bushes appeared to have spread from one original planting on a farm near the center of the area.

Near Mingo, Champaign County, Ohio, an area of escaped barberries was located late in 1919. Numerous bushes, ranging in size from 20 feet in height to mere seedlings, were found scattered over two farms. These bushes had originated from a single bush planted near one of the farmhouses more than 100 years ago, of which only the dead stump was to be found. (Fig. 3.)

Similar areas have been found in all States except Montana, North Dakota, and Wyoming. One escaped seedling was found in Montana and one in Wyoming, but none so far in North Dakota. Figure 4 shows the distribution of the escaped barberry bushes located from April 1, 1918, to December 31, 1920.

SUMMARY BY STATES.

COLORADO.

Beginning on June 10, 1918, a preliminary survey was made of the barberry situation in eastern Colorado. Because of the general distribution of the barberry, the prevalence of the aecial or yellow stage of the black stem rust on the bushes, and the extremely severe epidemics of this rust experienced in the past, it was decided to begin the eradication of the common barberry in this State. The reduction in the production of wheat in Colorado in 1917 due to black stem rust was estimated at 300,000 bushels. It was found that the amended horticultural inspection act contained a clause permitting the State entomologist to declare any harmful plant a pest. On July 20, 1918, a quarantine was established, forbidding the shipment of the common barberry from another State or country into the State or its shipment within the State. On July 25, 1919, an order was issued for the removal of barberry bushes within the limits of Colorado.

Organization for the field work was completed in August, 1918. Cities and towns and some rural territory were inspected and the location of all bushes was recorded. Letters and official notices, with a card to be signed and returned by the property owner when he had removed the bushes, were mailed by the State entomologist to those on whose property barberries were found. Publicity of various types was instituted, including some special features in addition

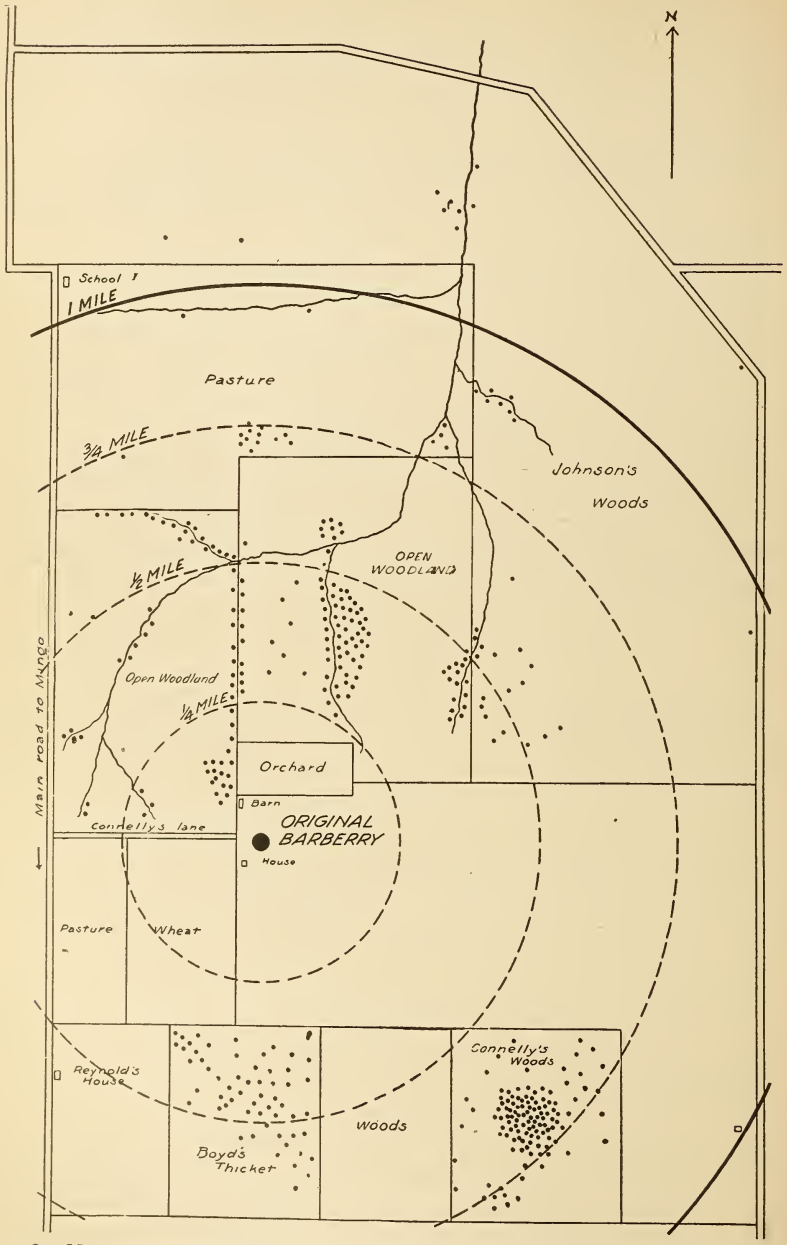

FIG. 3.—Map showing large numbers of escaped barberries (small dots) developed from seed scattered by birds from a single original bush (large dot) on a farm near Mingo, Champaign County, Ohio.

to those already noted. Inspection was carried on during the spring and summer of 1919, with the result that all the cities and towns and the greater part of the humid and irrigated agricultural districts were inspected. Portions of the State which are too mountainous or too dry for general farming or grain growing and which had been shown by preliminary inspection not to contain barberries were not included in the area inspected.

In addition to the cities and towns and farming communities in their immediate vicinities, the irrigated area from Denver to the northern line of the State was carefully inspected. This is a strip parallel with the eastern range of the Rocky Mountains and extending eastward toward the dry-land section as far as the highway from Denver to Platteville, then running eastward down the Platte

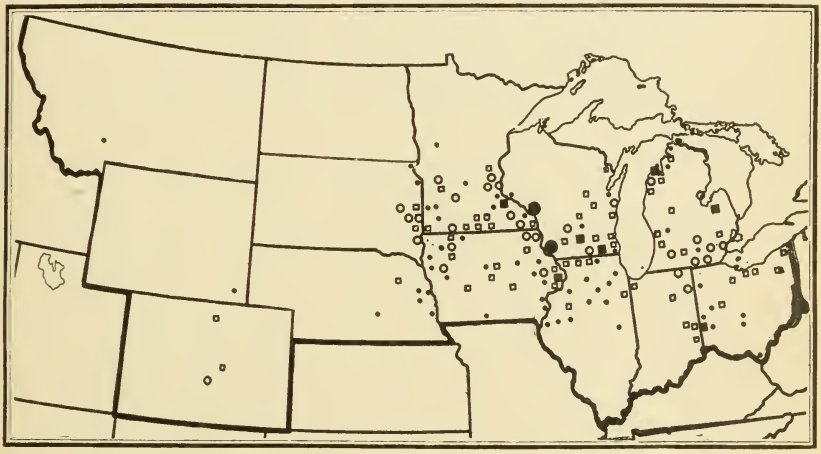

FIG. 4.—Outline map of the 13 States in the barberry eradication area, showing the distribution by counties of escaped barberry bushes which have grown from seeds scattered by birds or other agencies from cultivated bushes. Explanation: ⊙ =1 to 100 bushes, ◘ =101 to 1,000 bushes, ○ =1,001 to 10,000 bushes, ■ =10,001 to 100,000 bushes, ● =over 1,000,000 bushes.

Valley as far as Fort Morgan. The Arkansas Valley also was inspected, as was the irrigated section from Montrose to Delta and up to Paonia. Part of the rural area from Fruita to Palisades in the Grand Junction section was rather carefully investigated. The Platte River valley from Fort Morgan to the Nebraska line, except in the vicinity of the towns and the irrigated area directly east of Platteville, was not inspected and is to be covered later. It is possible that some of the dry-land areas should be more thoroughly surveyed, although the preliminary inspections have not seemed to warrant it.

During 1920 most of the areas already covered were reinspected for sprouting bushes and to assure the removal of any that might have been overlooked. In addition, a strip of varying width was

inspected in the cultivated valleys of Clear Creek, Grand, Eagle, Garfield, Mesa, Delta, Montrose, Ouray, San Miguel, Dolores, Montezuma, La Plata, San Juan, Archuleta, Rio Grande, Saguache, Conejos, Alamosa, Costilla, Huerfano, Las Animas, Fremont, Pueblo, Crowley, Otero, Bent, and Prowers Counties.

ILLINOIS.

The barberry-eradication campaign was begun in Illinois about April 15, 1918. The plant pathologist of the University of Illinois was chosen as the State representative, and a Federal representative directed publicity and field work. Two field assistants were employed during the summer months. An extensive publicity campaign was organized, and numerous State organizations aided in the work. Cooperation was established with the extension division of the College of Agriculture, and Circular No. 22 of the extension division was issued in April, 1918, for educational purposes. Informal cooperation was established also with the State department of agriculture.

During the first year 96 of the principal towns in about 47 counties were surveyed. In some counties only one town was inspected, while in others almost every town was visited. About 40,000 barberries were located. It is estimated that various unofficial agencies aiding in the campaign caused the eradication of upward of 250,000 additional bushes, including large numbers in commercial nurseries. Rust was found in abundance on the bushes, and its direct relationship to black stem rust on grain was fully demonstrated. A quarantine measure prohibiting the shipment and sale of the common barberry and all its horticultural varieties into or within the State was ordered by the State department of agriculture, effective on May 15, 1918. Amendments to the plant-inspection act of 1917 were approved on June 28, 1919. On August 12, 1919, a public notice was issued requiring the eradication of the tall-growing European barberry and all its horticultural varieties, including the purple-leafed barberry. Notices were also prepared by the State department of agriculture, notifying each person upon whose property barberries might be found of the presence of the objectionable bushes and requiring their removal. Preliminary surveys of a number of cities and towns in the southern part of the State showed that barberries had not been generally planted there as ornamental shrubs or hedges. The bushes located have not been found to rust so generally as those in northern Illinois. Therefore, intensive inspection has been deferred until the completion of the survey of those sections of the State in which the barberry is more abundant and more destructive.

To June 30, 1920, the campaign had been extended into 632 cities and towns, confined chiefly to the northern half of the State. Most of these, including the suburbs of Chicago, have been thoroughly inspected. All barberries have been removed from the city parks of Chicago, and boy scouts under the direction of leaders inspected and asked the removal of bushes from the principal residence districts. but no resurvey so far has been attempted there.

The principal work done in the rural districts during 1919 included only the inspection of properties reported to have barberries on them and the following up of reports of escaped bushes. A preliminary farm-to-farm survey was made in a few townships each of Champaign and McLean Counties. On July 1, 1920, a farm-to-farm survey was begun in Stephenson County. More than 1,000 bushes were located on 116 widely scattered farms. Escaped bushes numbering 850 were found on 92 properties. These were in pastures, woodlands, along stream banks, fence rows, on rocky hillsides, and in old stone quarries. Approximately 65 per cent of all bushes found in the county were rusted. Wheat fields near these bushes in all cases were more severely infected with rust than were those more distant. By the end of the field season the farm-to-farm survey of Boone and Winnebago Counties had been completed also.

INDIANA.

The barberry-eradication campaign in Indiana was launched on April 15, 1918. The chief of the department of botany of the Purdue University Agricultural Experiment Station was made State leader, and the extension pathologist was put in active charge of the campaign. Four field assistants were employed. Wide publicity was given the work through various State organizations as well as through influential citizens, who cooperated actively. State and county councils of defense, food-production committees and food administrators, mayors, town councils, park boards, the State department of public instruction, the State federation of farm associations, and other patriotic and public agencies urged the immediate destruction of all harmful barberry bushes. Surveys of both cities and towns were started. Records of all plantings and escaped bushes found by the field assistants were sent to the State headquarters, and from there letters were sent to the various property owners, with follow-up letters and reinspections until definite results were obtained. The response of the public was gratifying; 75 per cent of the plantings located in each community usually were removed within a month. Many other bushes removed by property owners were not reported by them for record.

By June 30, 1919, all cities and towns except Evansville and Terre Haute had been completely surveyed. These two cities were finished

later. The records to that date show 2,933 plantings, containing 79,218 bushes, located by the field inspectors, of which 2,698 plantings containing 72,266 bushes had been removed. A large percentage of these bushes were found to be infected with black stem rust. Sixteen properties, containing 2,018 bushes which had escaped from cultivation were found. About 20 cases of severe local epidemics of black stem rust of wheat were reported by farmers and county agents in various parts of the State. Upon investigation, in practically every case the rust was traced to barberry bushes in the immediate vicinity of these fields. The inspection covered 357 towns, 190 of which contained barberries.

In October, 1919, the State conservation commission made a ruling requiring the removal of all plants of the common barberry and its horticultural varieties. This ruling became effective November 29. Notices requiring removal then were mailed by the State entomologist to all property owners known to have harmful barberries.

A farm-to-farm survey was started in July, 1919, and a reinspection of towns in the areas covered was carried on simultaneously. Twelve counties were completed in 1919, and by December 31, 1920, seven more were added, making a total of 19 counties completed, namely, Allen, Boone, Clinton, Delaware, Elkhart, Grant, Hamilton, Hendricks, Henry, Howard, Knox, Lake, Laporte, Madison, Miami, Montgomery, Noble, Porter, and Tipton. Seventy-three counties remain to be surveyed in detail.

Records show that 3,165 bushes were located on 262 farms in the counties covered. A number of these were escaped from cultivation. In addition, numerous plantings in rural districts of other counties have been located and removed through various agencies, making a total of 10,134 bushes on 353 farms.

IOWA.

During 1917 a preliminary survey was made by the department of botany of the Iowa Agricultural Experiment Station, which showed that the common European barberry was widely distributed in Iowa and at many points was very abundant. Circular No. 35 was issued during that year, calling attention to the relation of barberries to black stem rust.

In April, 1918, the plant pathologist of the experiment station was appointed State leader. The Office of Cereal Investigations of the Bureau of Plant Industry furnished an assistant State leader and field men to make surveys and to emphasize the urgent need of the removal of all barberry bushes. Cooperation was established with the extension division, which furnished the means for publicity. Every organization in the State and every individual was called upon to aid

in the eradication of barberries to safeguard the wheat crop. On April 9, 1918, the governor of the State issued a proclamation urging the people to dig, burn, or otherwise destroy the common barberry bush wherever found.

During 1918 the campaign was carried into every county in the State. In some counties only a few of the towns were visited, for lack of time; however, 298 of the largest towns were inspected, and approximately 130,000 bushes were destroyed by the owners of commercial nurseries. The inspectors found that in many cases bushes had been removed before they arrived. The greater number of the bushes were found in the tier of counties along the Mississippi River. Eight cases of escaped barberries were recorded by the field men, and it was observed that these usually were seedlings grown from seeds scattered by birds.

Twelve local rust epidemics were found, directly traceable to infected barberry bushes, which were in nearly all cases near the center of the infected areas. In each epidemic the grasses and cereals nearest the barberry bushes showed the earliest and heaviest infection, and the severity of infection decreased as the distance from the barberry increased.

An amendment to the Iowa crop-pest law became effective on February 10, 1919. This amendment empowered the State entomologist to cause the removal of the common barberry from all properties in the State.

The survey of every city and every town with a population over 100 was completed by June 30, 1919. A resurvey was made of all plantings found the previous year but not reported removed, as well as a careful reinspection for sprouts from poorly removed bushes.

A preliminary farm-to-farm survey was begun in Story County. The results were such that the farm-to-farm survey was continued vigorously. By December 31, 1920, the following northwestern counties had been surveyed: Lyon, Osceola, Dickinson, Emmet, Sioux, O'Brien, Clay, Palo Alto, Plymouth, Cherokee, Buena Vista, Pocahontas, Woodbury, Ida, Sac, and Crawford; also the greater part of Story County, in central Iowa.

MICHIGAN.

The barberry-eradication campaign had its beginning in Michigan in April, 1918. After a preliminary survey which emphasized the facts already known, i. e., that there were numerous barberries in almost all parts of the State, the Agricultural College and the State inspector of nurseries and orchards issued a bulletin entitled "Kill the Barberry," which showed the necessity of removing the common barberry and its purple-leafed variety. State leadership was furnished by the department of botany of the experiment station. An

assistant leader and field assistants were furnished by the Office of Cereal Investigations of the Bureau of Plant Industry. Cooperation was begun on April 15, 1918, with the State inspector of orchards and nurseries, who furnished a limited sum of money for inspection and eradication. Various State agencies were used for the furtherance of publicity, especially the schools, boy-scout organizations, and war-emergency boards.

Inspection showed even more barberries than the preliminary survey indicated and revealed many barberries planted on farms and many escaped bushes, indicating that a farm-to-farm survey would be necessary. The barberry bushes usually were badly infected. Local and even some general outbreaks of rust on grain were noted. While these were not numerous, they were easily traceable in most cases to infected barberries in the vicinity of the most severely infected fields. Cooperation was established with the extension division of the Agricultural College in March, 1919.

An amendment to act 91 of the public acts of 1905 became effective early in 1919, which made it unlawful for anyone to keep upon his premises any variety of barberry bushes likely to harbor and spread rust. On May 2, 1919, the governor of the State, in an Arbor Day proclamation, called special attention to this act. The State inspector of nurseries and orchards issued an order requiring the destruction of all green-leafed and purple-leafed tall or high-bush barberries and mahonias and also issued notice to property owners having barberry bushes. With each notice a return card was sent, to be signed and returned by the property owner as soon as the bushes were removed.

In the city and village survey all counties in the southern peninsula and most of those in the northern peninsula were visited. It was estimated that through publicity and the efforts of inspectors and individuals, approximately 200,000 bushes were removed from nurseries, parks, and lawns which were not reported to the State office for definite record.

During 1918 and 1919 27 distinct areas, including hundreds of properties, were located in which escaped barberries were found in large numbers. These were in widely scattered parts of the lower peninsula and ranged from a few to thousands of bushes on each property. In a portion of these areas properties have been carefully surveyed and 60,380 bushes located. A preliminary farm-to-farm survey was made in a few townships in the autumn of 1919. On July 1, 1920, a systematic survey was begun in Monroe County. By December 31, 1920, Monroe, Lenawee, Hillsdale, Branch, and Ingham Counties, and a few townships in Livingston County had been completely surveyed.

MINNESOTA.

On March 19, 1918, the Minnesota Commission of Public Safety, an emergency war board, upon the recommendation of the Minnesota College of Agriculture, issued order No. 28, inaugurating a rigid campaign against the barberry. This State was one of the first to take such action. Cooperation was established between the College of Agriculture and the Office of Cereal Investigations, Bureau of Plant Industry.

The work was immediately begun along the three lines of publicity, survey, and eradication. Publicity was accomplished through all the usual channels and was supplemented by a systematic survey carried on by field inspectors traveling on foot. Travel between towns usually was by rail. Towns and rural communities not accessible by railroad were visited by means of a buggy or automobile. State nursery inspectors, county agents, and agricultural instructors freely cooperated in the publicity work and survey. Whenever bushes were located, if not immediately removed they were tagged. Many people, seeing these tags, made inquiries, thereby aiding in spreading information and in locating other plantings. Records were made of the name and address of the property owner and the exact location of the bushes and forwarded to the central State office.

Thousands of barberry bushes of which no records were obtained were destroyed voluntarily by property owners; many others were removed after the owners had submitted samples for identification. The greater portion of the bushes not voluntarily eradicated were removed readily by the property owners on receiving information regarding the order against the common barberry.

Order No. 28 of the Minnesota Commission of Public Safety was replaced by a State law effective on March 21, 1919, which declared that all species of barberry except the Japanese barberry and all species of mahonia were a nuisance and a menace to the public welfare. This placed the campaign on a more permanent basis. It was extended from a city-and-town survey to include also a farm-to-farm inspection. By December 31, 1920, the campaign had extended into 365 cities and towns in 84 counties.

On July 20, 1919, a thorough inspection of rural communities was begun. In 1919 Cottonwood, Freeborn, and Rock Counties were completely surveyed. Portions of Brown, Jackson, Kandiyohi, Mower, Nicollet, Nobles, Olmstead, and Renville Counties were surveyed. During 1920 a resurvey of cities and towns was made in connection with the rural survey, which was completed in Jackson, Lac qui Parle, Lincoln, Lyon, Martin, Murray, Nobles, Yellow Medicine, and Pipestone Counties. Some work also has been done in Winona and Faribault Counties. At least 60 counties remain to be covered in the farm-to-farm survey.

MONTANA.

Montana is on the western border of the eradication area. The campaign for the eradication of the barberry was inaugurated there in March, 1918. A preliminary survey only was accomplished in 1918. The conditions in this State are very different from those in the main part of the barberry-eradication area. While wheat is grown in almost every county the State is relatively new from the agricultural standpoint. Extensive plantings of shrubbery or ornamentals have not been made. The number of barberries, therefore, was supposed to be comparatively small. Nevertheless, the preliminary observations made during 1918 showed that scattered barberries were to be found in all parts of the State and that extensive traveling would be necessary to locate them. The State College of Agriculture and the Office of Cereal Investigations of the Bureau of Plant Industry entered into cooperation in January, 1919. The botanist of the college was chosen as State leader, and an assistant State leader was employed. All cities and towns likely to contain this shrub were carefully surveyed. The ranches and farms of practically all irrigated lands and main river valleys of the older settled areas were surveyed during 1919 and 1920. The territory covered was great, but the barberries found were not numerous.

Barberries were found in abundance in two districts, the Flathead Valley, near Kalispell, which contained 40 per cent of the barberries located in the State, and the Billings district on the Yellowstone River, which contained 20 per cent of the total. A considerable number of small plantings were found in the Bitter Root Valley (Ravalli County). The eastern half of the State had very few plantings, with the exception of the Yellowstone Valley, an older settled district. The Missouri Valley below Great Falls and adjacent territory were noticeably free from this shrub. No barberries were found outside of the river valleys in the mountainous districts. Of all the barberries found 75 per cent were in the cities and towns. Of the 25 per cent found in the rural districts nine-tenths were in large plantings in three counties, Flathead, Yellowstone, and Lewis and Clark. But one escaped barberry, a seedling under a tree at Bozeman, was found.

All portions of the State where barberries were found on the original survey have been completely resurveyed for sprouts, and all found have been eradicated. It will be necessary to resurvey certain properties for sprouts and to follow up any local outbreaks of rust that may occur for their possible connection with local barberries missed. Only two cases of rust were reported in the State during 1920. One outbreak was on a farm in Richland County. The rust was not abundant, and it infected the grain so late in the season that it caused practically no loss.

NEBRASKA.

The barberry-eradication campaign was launched in Nebraska in March, 1918, following a conference of plant pathologists at Lincoln. The State plant pathologist was made leader. An assistant leader and a field assistant were employed by the United States Department of Agriculture. A preliminary field survey showed that barberry bushes were abundant in the larger cities and towns. The publicity campaign was then launched. The public schools, colleges, and many State organizations were enlisted in spreading information about barberries and wheat rust. The State Council of Defense passed a resolution condemning the barberry, and this was soon followed by ordinances in many municipalities. The governor designated May 4, 1918, as "Berberry Eradication Day" and enlisted the efforts of all the citizens of the State in the destruction of this enemy of wheat. All the nurseries in the State cooperated to the extent that they destroyed all their stocks of the common barberry. Since that time no more barberries have been sold in the State, although the law prohibiting the sale did not become effective until 1919. Through various agencies barberry literature and posters were thoroughly distributed. Later in 1918 a systematic inspection was begun by field men. The State legislature of 1919 enacted a law requiring the removal of all barberry bushes except the Japanese variety. This law carries a clause requiring removal on 10 days' notice and orders the county sheriff to dispose of bushes upon notice from the State plant pathologist.

Preliminary inspection by automobile revealed so many barberries in the rural districts that a farm-to-farm survey was found necessary. A summary of the first year's work showed that barberries were present in every part of the State surveyed and that large numbers of bushes had been planted in the more thickly settled portions. The prevailing idea that the State had very few barberries and that those present did not rust was found to be contrary to fact. The work of the season of 1918 showed that the barberry was severely rusted over the entire State except a small portion south and east of Lincoln, and even here there was some infection. During 1919 rust was found again on barberries throughout the State. The severity of infection was practically the same as in 1918, but the rust appeared earlier. During the spring of 1920 barberries rusted badly, and rust developed earlier and more abundantly near infected barberries. Later in the season it became general in many parts of the State. In April, 1920, cooperation was established with the extension division of the College of Agriculture.

In the urban survey most of the cities and towns have been inspected. Many have been reinspected for sprouts and to make

certain that bushes located were removed. A farm-to-farm survey was begun in 1919. The township was used as the unit. Portions of Butler, Clay, Custer, Johnson, York, and Washington Counties and all of Adams, Dodge, Lancaster, Saunders, and Seward Counties were surveyed during that season. Since July 1, 1920, surveys of portions of Butler, Washington, Sarpy, Johnson, and Pierce and all of Colfax, Cuming, Burt, Thurston, Dakota, and Wayne Counties have been completed, making the equivalent of 17 counties completely surveyed.

NORTH DAKOTA.

The barberry-eradication campaign in North Dakota was inaugurated by that State in June, 1917, a year before the general campaign was begun. In that year a law compelling the destruction of the common barberry was passed and an appropriation of $2,500 for its eradication was made by the State legislature.

For two years the work was carried on by the State department of agriculture in cooperation with the North Dakota Agricultural College. A leader appointed by the State commissioner of agriculture had charge of the campaign. The leader, with two assistants, made a 3-month survey during the summers of 1917 and 1918. Most of the larger towns and cities east of the Missouri River were surveyed, and it was estimated that approximately 10,000 bushes were removed. Many of these, of which no records were obtained, were destroyed voluntarily by property owners. Field reports filed at the Agricultural College show that 241 plantings containing 1,876 bushes were located in the towns and 3 plantings of 41 bushes in the country, making a recorded total of 1,917 bushes located during the period from June 10, 1917, to June 30, 1919, while the work was carried on by the State.

As the State records were not complete, a resurvey has been carried on since the barberry-eradication campaign has been conducted in cooperation with the United States Department of Agriculture. It was found that approximately one-third of these bushes had been improperly removed, having been cut down to the ground instead of being grubbed out by the roots. Such plants usually were found to be sprouting. Every planting reported since June 10, 1917, has been revisited in order to make sure that the bushes have been eradicated.

Since the spring of 1919, when active cooperation was begun between the State and the United States Department of Agriculture, every town has been completely resurveyed and a farm-to-farm survey by counties has been begun. During 1919 Richland and Stutsman Counties and the greater part of Barnes and Cass Counties were completely surveyed. In 1920 Pembina, Walsh, Grand Forks, Steele, Traill, Sargent, and Dickey Counties have been added to the list,

making 11 in all. A number of rural plantings have been located in each county, but thus far no escaped bushes have been found. All bushes are removed as found.

OHIO.

In western Ohio and eastern Indiana is located the Miami Valley. This has long been recognized as one of the principal winter-wheat districts. A 3-year crop rotation, with wheat as the principal small-grain crop, has been well established, so that on most farms a fixed acreage of winter wheat is sown each year. Black stem rust has caused losses of wheat almost every year, and in some localities the loss has been exceedingly great.

Investigations were inaugurated by the United States Department of Agriculture in cooperation with the department of botany of the Ohio Agricultural Experiment Station about April 1, 1918. The chief botanist was chosen as State leader. An assistant State leader and two field assistants were employed during a portion of the summer. The primary aim was to determine the distribution of the barberry and of rust in the State. It was established that the common barberry was important in disseminating the black stem rust of cereals in various sections.

In the survey many barberries have been located, some of which were old hedges planted two generations ago and some ornamentals planted in more recent years. Barberries also have escaped to woodlots, fence rows, and banks of streams in many parts of the State. Wherever the barberry is near wheat fields the grain has been so badly rusted each year that in many cases the growing of it has been discontinued. These local outbreaks in some cases had already been connected with the presence of barberries, and their eradication had been undertaken in some communities 20 years ago. The presence of escaped bushes which had not been found usually made these efforts of small avail.

The results of this investigation were given widespread publicity by means of the public press, informal conferences, and the distribution of thousands of copies of the bulletin entitled "Black Stem Rust of Wheat: Barberry Bushes Dangerous," which was issued by the Ohio Agricultural Experiment Station. Circulars, posters, and bulletins of the United States Department of Agriculture were also distributed.

On April 14, 1919, cooperation was established with the College of Agriculture of Ohio State University, Columbus, Ohio. The extension pathologist was chosen as a collaborator. The State leader and field assistants were employed by the Office of Cereal Investigations of the Bureau of Plant Industry. A vigorous campaign aiming at the ultimate extermination of all rust-susceptible bar-

berries in the State was then begun. Publicity was maintained by the distribution of bulletins and posters, talks before agricultural organizations and in schools, and the sending out of form letters.

All cities and towns of over 300 inhabitants, except Cincinnati, were surveyed during the year 1919. In traveling from one town to the next many farms were visited, and it was found that there were many barberries on farms and also that escaped bushes occurred within the State. During 1920 efforts were concentrated on the farm-to-farm survey. Green, Montgomery, Preble, Darke, Mercer, and Van Wert Counties were completely surveyed, as also more than half of Paulding and Defiance Counties. From 10 to 100 rural plantings of the common barberry were located in each of the counties named. In 16 instances barberries were found escaped from cultivation. The escaped bushes in each of these areas had been causing severe rust damage in the immediate locality.

SOUTH DAKOTA.

The barberry-eradication campaign in South Dakota was begun early in April, 1918, when the work of publicity and education was inaugurated by the United States Department of Agriculture in cooperation with the department of agronomy of the State Agricultural College. During that season two field men were employed. In most of the counties east of the Missouri River there were county agents or emergency demonstration agents whose cooperation was enlisted through the extension division of the college. In counties where there were no agents, interested individuals or organizations cooperated. West of the Missouri River the country is comparatively new, agriculturally speaking, and in the towns of this section little ornamental planting has been done. No large towns or cities are found except in the Black Hills. However, county agents in that part of the State joined in the work, so that the campaign was extended over the entire State. An effort was made to keep records of the work of all agencies. The work was done rather hurriedly and not systematically, the efforts being expended where the most could be accomplished in the shortest time.

During the latter part of 1918 the work was more thoroughly organized and a systematic survey was begun. The greater part of the field work was confined to a survey of cities and towns. All towns with a population of 100 or more, 640 in all, were surveyed, and barberries were found in 108 of them. In connection with this work a number of rural plantings of barberries were located. To ascertain the necessity for a farm-to-farm survey, Lake County was chosen. Beginning in July, 1919, a survey of every farm was made, all groves and shrubbery being carefully inspected. Many barberries were located in the rural districts, showing that no farm in the area covered

was over 8½ miles from the nearest barberry bush. A more surprising fact was that on 11 of the 24 farms on which barberries were located in that county escaped seedling barberries were found, and in some cases these apparently had been brought by birds from near-by farms. While these seedlings were not large, in 10 more years these escaped bushes would have become so large and well established as to make eradication a difficult matter, and this county probably would have had more severe rust injury to wheat.

At the end of the second year a bulletin on barberry eradication was published by the extension division of the State Agricultural College, which gave considerably more publicity to the campaign. Careful studies in the vicinity of at least six infected hedges brought out clearly the relation of the barberry to the development of the rust in near-by grain fields. Moreover, observations indicate that approximately 75 per cent of the barberries in South Dakota became infected with rust last year in May and June. During 1920 all field work was devoted to a rural survey, so that by December 31, Brookings, Deuel, Grant, Lake, Lincoln, Minnehaha, Moody, and Roberts Counties had been completely surveyed. All counties east of the Missouri River will require close inspection. A farm-to-farm survey of most of the counties west of the river probably will not be necessary.

WISCONSIN.

In Wisconsin barberry eradication began in April, 1918. The plant pathologist and the extension pathologist of the Wisconsin Agricultural Experiment Station and the State entomologist of the State department of agriculture cooperated with the United States Department of Agriculture in an extensive publicity campaign. An edition of 45,000 copies of Wisconsin Extension Circular No. 102, entitled "Pull the Dangerous Barberry Bushes and Save the Wheat Crop," was distributed. Letters were written to county agricultural agents, park superintendents, mayors, school principals, commercial clubs, and the officials of all State institutions, making a strong appeal to their loyalty and patriotism in eradicating this widespread enemy of grain production. Liberal use was made of posters, and the press of the State gave the campaign its enthusiastic support. Because of this publicity bushes estimated to be in excess of 100,000 were eradicated voluntarily, without records being furnished to the State authorities.

Active field work was commenced also in April, 1918, and five to eight field assistants were employed throughout the season. They made a house-to-house canvass of all the 130 cities of the State having over 1,000 inhabitants. All barberries found were removed if possible, and later in the same season most of these plantings were reinspected for possible sprouts.

During the summer of 1919 villages of less than 1,000 inhabitants were inspected in the same way, and practically all barberries found were removed. By the end of the season, practically all cities and villages in Wisconsin had been inspected for barberries. The greater number of these also had been reinspected for sprouts. In the city of Milwaukee the work was carried on with the aid of boy scouts and high-school students, who located bushes and notified the owners that they should be removed. No effort was made in this city to keep a record of the number of barberries found and removed or of their location. A necessary reinspection has not yet been completed.

In addition to those in the cities and villages, numerous plantings were located in the country by inspectors traveling along the highways from one village to another. At that time, however, no farm-to-farm survey of any country district was attempted.

In many places in Wisconsin very old plantings of barberries were found. Some of these are known to have been planted more than 70 years ago. From these, seeds had been distributed by birds and by other means over the near-by fields, and thus escaped barberries had developed. By the end of December, 1920, such escaped barberries had been found on 309 properties in at least 25 different localities. These bushes varied in number from only a few in many places to more than 1,000,000 in each of two areas and were scattered over areas varying from less than an acre to more than 20 square miles. Most of these have been eradicated, including those on the largest area at Trempealeau, along the Mississippi River, from which over 1,500,000 barberries were removed.

To December 31, 1920, practically every city and village in the State except Milwaukee has been carefully inspected for barberries and most of them reinspected for sprouts. The escaped bushes in at least 22 areas have been eradicated. Bushes to the number of 3,306,183 were recorded, of which 3,024,352 were escaped from cultivation. Of this total 2,213,955 have been removed. Of the 1,092,228 not yet removed, about 1,000,000 are seedling bushes under 18 inches in height on one farm in Grant County, more particularly described on page 20. No doubt many bushes remain in the country, and these can be located only by the very careful farm-to-farm survey now in progress. This survey has been completed in Kenosha, Racine, Walworth, and Milwaukee Counties.

WYOMING.

Early in the spring of 1918 a publicity campaign for barberry eradication was begun in Wyoming. The botanist at the University of Wyoming was selected as leader, especially to represent the State. A preliminary survey was conducted by a single field man during

August and September. Barberry bushes were located in most of the principal cities and towns. Some rusted barberries were located, and rusted grain was found in many places. During the summer of 1919 a publicity campaign was conducted through various channels, and the survey was enlarged. In the absence of an adequate law, only such barberries were eradicated as were removed voluntarily by the property owners after the field inspectors had informed them of their location. Where permission was granted, the field men themselves removed some bushes.

In April, 1920, cooperation was established with the extension division of the University of Wyoming. The director of extension became a collaborator, and in July, 1920, the various operations were renewed under the full-time direction of a representative of the United States Department of Agriculture as the State leader.

During the entire campaign from August, 1918, to December 31, 1920, a total of 4,100 bushes was located on 77 properties. Of these bushes only 492 were removed from 24 properties. In the preliminary rural survey 168 bushes were located on 7 properties. More preliminary rural surveys are necessary to determine definitely just what areas must be covered in the farm-to-farm survey. Plans have been made for the inspection of the ranches and farms of the older settled portions in the counties of the eastern portion of the State.

A law providing for the eradication of harmful species and varieties of barberries was approved on February 22, 1921. This makes it unlawful to sell, transport, plant, or permit to exist on any premises in the State of Wyoming any plant of the harmful barberry. Enforcement rests with the State horticultural board. It is believed that the campaign in the State now can be carried forward with complete success.

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